



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

# Advisory Circular

**Subject: PROGRAM TO ENHANCE  
AIRCRAFT ELECTRICAL WIRING  
INTERCONNECTION SYSTEM  
MAINTENANCE**

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## 1. [PURPOSE](#)

This Advisory Circular (AC) provides guidance for developing enhanced electrical wiring interconnection system (EWIS) maintenance for air carriers, air operators, holders of type certificates, holders of supplemental type certificates (STCs), maintenance providers, repair stations, and persons

performing field approval modifications or repairs. The guidance in this AC is based on recommendations submitted to the FAA from the Aging Transport Systems Rulemaking Advisory Committee (ATSRAC). The information in this AC is derived from the maintenance, inspection, and alteration best practices identified through extensive research by ATSRAC working groups and Federal government working groups. This AC provides a means for the FAA to officially endorse these best practices and to dispense this information industry wide so that the safety benefits of this information can be realized. Adoption of the recommendations in this AC will improve the awareness throughout the aviation industry of the importance of visual inspections of aircraft systems, particularly aircraft EWIS. This AC promotes a housekeeping philosophy of “protect, clean as you go” when performing maintenance, repair, or alterations on or around aircraft EWIS. This guidance is equally applicable to non-wiring related maintenance and modification activities where those activities could cause inadvertent contamination or damage to wiring.

## 2. OBJECTIVE.

The objective of this AC is to enhance the maintenance of aircraft EWIS through adoption by the aviation industry of the following:

- (1) Enhanced Zonal Analysis Procedure (EZAP). This AC presents an “enhanced zonal analysis procedure” and logic that will benefit all aircraft regardless of whether they currently have a structured zonal inspection program (see Appendix A. Enhanced Zonal Analysis Logic Diagram and Steps and Appendix B. EZAP Worksheets). Application of this procedure will ensure that appropriate attention is given to wiring installations. Using EZAP it will be possible to select stand-alone inspections (either General or Detailed) and tasks to minimize the presence of combustible material. The procedure and logic in this AC complement existing zonal analysis procedures and will also allow the identification of new wiring tasks for those aircraft that do not have a structured zonal inspection program.
- (2) Guidance for General Visual Inspection (GVI). This AC provides clarification of the definition for a General Visual Inspection and provides guidance on what is expected from such an inspection, whether performed as a stand-alone GVI or as part of a zonal inspection.
- (3) Protections and Cautions. This AC identifies protection and cautions to be added to maintenance instructions, thereby enhancing procedures that will lead to minimization of contamination and accidental damage while working on the aircraft.

The enhanced aircraft wiring maintenance information described in this AC is intended to improve maintenance and inspection programs for all aircraft systems. This information, when used appropriately, will improve the likelihood that EWIS degradation, including age related problems, will be identified and corrected. Therefore, the goal of enhanced wiring maintenance information is to ensure that maintenance actions, such as inspection, repair, overhaul, replacement of parts, and preservation, do not cause a loss of EWIS function, do not cause an increase in the potential for smoke

and fire in the aircraft, and do not inhibit the safe operation of the aircraft.

To fully realize the objectives of this AC, air carriers, air operators, type certificate holders, STC holders, maintenance providers, repair stations and persons performing field approval modifications or repairs, will need to rethink their current approach to maintaining and modifying aircraft wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aircraft EWIS should be maintained with the same level of intensity as any other system in the aircraft. They also need to recognize that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulations, especially in small gage wire may not always be apparent. Therefore effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

Good wiring maintenance practices should contain a "**protect, clean as you go**" housekeeping philosophy. In other words, care should be taken to protect wire bundles and connectors during work, and to ensure that all shavings, debris and contamination are cleaned up after work is completed. This philosophy is a proactive approach to EWIS health. Wiring needs to be given special attention when maintenance is being performed on it, or around it. This is especially true when performing structural repairs, work under STCs or field approvals, or other modifications.

To fully achieve the objectives of this AC it is imperative that all personnel performing maintenance on or around EWIS receive appropriate training. In addition to technical content regarding maintenance and inspection of EWISs, the training should also include sections on good maintenance practices, including the "protect, clean as you go" housekeeping philosophy. Advisory Circular AC 120-YY, Aircraft Wiring Systems Training Program, contains guidance on recommended content and lesson plans for this training.

### 3. APPLICABILITY.

- a. The guidance provided in this document is directed to air carriers, air operators, type certificate holders, STC holders, maintenance providers, repair stations and persons performing field approval modifications or repairs.
- b. The guidance provided in this AC can be applied to all airplane maintenance or inspection programs. The Enhanced Zonal Analysis Procedure in Appendix A of this AC is specifically directed towards enhancing the maintenance programs for aircraft whose current program does not include tasks derived from a process that specifically considers wiring in all zones as the potential source of ignition of a fire.
- c. This AC is not mandatory and does not constitute a regulation. This AC describes acceptable means, but not the only means, of developing, implementing and evaluating enhanced aircraft EWIS maintenance and inspection methods, practices and techniques.

4. RELATED 14 CFR PARTS.

- a. Part 21, Certification Procedures for Products and Parts.
- b. Part 25, Airworthiness standards: Transport category airplanes.
- c. Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration.
- d. Part 91, General Operating and Flight Rules.
- e. Part 119, Certification: Air Carriers and Commercial Operators.
- f. Part 121, Operating Requirements: Domestic, Flag, and Supplemental Operations.
- g. Part 125, Certification and Operations: Airplanes Having a Seating Capacity of 20 or More Passengers or a Maximum Payload Capacity of 6,000 pounds or More.
- h. Part 129, Operations: Foreign Air Carriers and Foreign Operators of U.S.-Registered Aircraft Engaged in Common Carriage.
- i. Part 145, Repair Stations

5. RELATED READING MATERIAL.a. Advisory Circulars (ACs).

- (1) AC 25-16           Electrical Fault and Fire Protection and Prevention
- (2) AC 25.981-1B    Fuel Tank Ignition Source Prevention Guidelines
- (3) AC 43-12A        Preventive Maintenance
- (4) AC 43.13-1B     Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
- (5) AC 43-204        Visual Inspection For Aircraft
- (6) AC 43-206        Avionics Cleaning and Corrosion Prevention/Control

- (7) AC 65-15A      Airframe & Powerplant Mechanics Airframe Handbook, Chapter 11, Aircraft Electrical Systems
- (8) AC 120-YY      Aircraft Wiring Systems Training Program

**b. Reports.**

(1) Transport Aircraft Intrusive Inspection Project, (An Analysis Of The Wire Installations Of Six Decommissioned Aircraft), Final Report, The Intrusive Inspection Working Group, December 29, 2000.

[http://www.mitrecaasd.org/atrac/intrusive\\_inspection.html](http://www.mitrecaasd.org/atrac/intrusive_inspection.html)

(2) FAA Aging Transport Non-Structural Systems Plan, July 1998.

<http://www.faa.gov/apa/PUBLICAT/fatnspcov.htm>

(3) National Transportation Safety Board, Safety Recommendation, September 19, 2000, A-00-105 through -108.

[http://www.nts.gov/recs/letters/2000/A00\\_105\\_108.pdf](http://www.nts.gov/recs/letters/2000/A00_105_108.pdf)

(4) Wire System Safety Interagency Working Group, National Science and Technology Council, Review of Federal Programs for Wire System Safety 46 (2000).

[http://www.ostp.gov/html/wire\\_rpt.pdf](http://www.ostp.gov/html/wire_rpt.pdf)

(5) Aging Transport Systems Rulemaking Advisory Committee, Task 1 & 2, Aging Systems, Final Report.

[http://www.mitrecaasd.org/atrac/final\\_reports/Task\\_1&2\\_Final%20August\\_2000.pdf](http://www.mitrecaasd.org/atrac/final_reports/Task_1&2_Final%20August_2000.pdf)

(6) Aging Transport Systems Rulemaking Advisory Committee, Task 3, Final Report.

[http://www.mitrecaasd.org/atrac/final\\_reports/Task\\_3\\_Final.pdf](http://www.mitrecaasd.org/atrac/final_reports/Task_3_Final.pdf)

(7) Aging Transport Systems Rulemaking Advisory Committee, Task 4, Final Report, Standard Wiring Practices.

[http://www.mitrecaasd.org/atrac/final\\_reports/Task\\_4\\_Final\\_Report\\_Sept\\_2000.pdf](http://www.mitrecaasd.org/atrac/final_reports/Task_4_Final_Report_Sept_2000.pdf)

(8) Aging Transport Systems Rulemaking Advisory Committee, Task 5, Final Report, Aircraft Wiring Systems Training Curriculum and Lesson Plans.

[http://www.mitrecaasd.org/atrac/final\\_reports/Task\\_5\\_Final\\_March\\_2001%20.pdf](http://www.mitrecaasd.org/atrac/final_reports/Task_5_Final_March_2001%20.pdf)

(9) ATA Specification 117 (Wiring Maintenance Practices/Guidelines).

<http://www.airlines.org/public/publications/display1.asp?nid=939>

**c. Other Documents.**

(1) Operator/Manufacturer Scheduled Maintenance Development, Revision 2001, ATA Maintenance Steering Group (MSG-3). May be obtained from the Air Transport Association of America; Suite 1100, 1301 Pennsylvania Ave, NW, Washington, DC 20004-1707.

(2) FAA Inspector's Handbook Bulletin 8300.10 titled "Origin and Propagation of Inaccessible Aircraft Fire under In-flight Airflow Conditions."

## 6. DEFINITIONS.

Arc tracking. A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally a result of electrical arcing. Also referred to as "Carbon Arc Tracking," "Wet Arc Tracking," or "Dry Arc Tracking."

Combustible. For the purposes of this AC the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

Contamination. For the purposes of this AC, wiring contamination refers to either of the following:

- a. The presence of a foreign material that is likely to cause degradation of wiring.
- b. The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

Detailed Inspection (DET). An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

Electrical Wire Interconnection System (EWIS). An electrical connection between two or more points including the associated termination devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification. (See Appendix D, Electrical Wire Interconnection System.)

Functional Failure. Failure of an item to perform its intended function within specified limits.

General Visual Inspection (GVI). A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available

lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection. The protection of airplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aircraft specific devices, e.g., RF Gaskets.

Maintenance. As defined in 14 CFR 1.1 “maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance.” For the purposes of this advisory circular, it also includes preventive maintenance as described in both § 1.1 and 14 CFR part 43, Appendix A(c).

Maintenance Significant Item (MSI). Items identified by the manufacturer whose failure could result in one or more of the following:

- A. could affect safety (on ground or in flight).
- B. is undetectable during operations.
- C. could have significant operational impact.
- D. could have significant economic impact.

Needling. The puncturing of a wire’s insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

Stand-alone GVI. A General Visual Inspection which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the Stand-alone GVI shall remain an independent step within the work card.

Structural Significant Item (SSI). Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.

Swarf. A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

Zonal Inspection. A collective term comprising selected General Visual Inspections and visual checks that are applied to each zone, defined by access and area, to check system and power plant installations and structure for security and general condition.

## 7. BACKGROUND.

Over the years there have been a number of in-flight smoke and fire events where contamination

sustained and caused the fire to spread. The FAA and the NTSB have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. In some cases dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example a person performing an inspection of an electrical power center or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

In recent years Federal government and industry groups have come to the realization that current maintenance practices may not be adequate to address aging non-structural systems. While age is not the sole cause of wire degradation, the probability that inadequate maintenance, contamination, improper repair, or mechanical damage has caused degradation to a particular EWIS increases over time. Studies by industry and government agency working groups have found that although EWIS management is an important safety issue, there has been a tendency to be complacent about EWIS. These working groups have concluded that there is a need to manage EWIS so that they continue to function safely.

#### 8. WIRE DEGRADATION.

Normal maintenance actions, even using acceptable methods, techniques and practices, can over time be a contributing factor to wire degradation. Zones that are subject to a high level of maintenance activity display more deterioration of the wiring insulation than those areas not subject to frequent maintenance. Degradation of wiring is further accelerated when inappropriate maintenance practices are used. Examples include the practice of needling wires to test the continuity or voltage, and using a metal wire or rod as a guide to feed new wires into an existing bundle. These practices could cause a breach in the wiring insulation that can contribute to arcing.

Over time, insulation can crack or breach, thereby exposing the conductor. This breakdown, coupled with maintenance actions, can exacerbate EWIS malfunction. Wiring that is undisturbed will have less degradation than wiring that is disturbed during maintenance.

For additional information on the principle causes of wire degradation see Appendix E.

#### 9. INSPECTION OF ELECTRICAL WIRING INTERCONNECTION SYSTEMS.

Typical analytical methods used for the development of maintenance programs have not provided a focus on wiring. As a result most operators have not adequately addressed deterioration of EWIS in their programs. The FAA has reviewed the current inspection philosophies with the objectives of

identifying improvements that could lead to a more consistent application of the inspection requirements, whether they are Zonal, Stand-alone GVI, or DET inspections.

The FAA believes that it would be beneficial to provide guidance on the type of deterioration that a person performing a GVI, DET, or Zonal Inspection would be expected to discover. Though it may be realistically assumed that all operators provide such guidance to their inspectors, it is evident that significant variations exist and, in certain areas of the world, a significant enhancement of the inspection could be obtained if internationally agreed guidance material could be produced. The guidance provided by this AC assumes each operator will adopt recent improvements made to the definitions of GVI and DET Inspections. This information should be incorporated in operators' training material and in the introductory section of maintenance planning documentation.

This section is divided into three parts. The first part addresses the levels of inspection applicable to EWIS, the second part provides guidance for performing zonal inspections, and the third part provides lists of installations and areas of concern.

**a. Levels of inspection applicable to EWIS.**

**(1) Detailed Inspection (DET).**

*An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.*

A DET can be more than just a visual inspection since it may include tactile assessment in which a component or assembly is checked for tightness/security. This is of particular significance when identifying applicable and effective tasks to ensure the continued integrity of installations such as bonding jumpers, terminal connectors, etc.

*Note: Though the term Detailed Visual Inspection remains valid for DETs using only eyesight, it should be recognized that this may represent only part of the inspection called for in the source documents used to establish an operator's Maintenance Program. For this reason it is recommend that the acronym "DVI" not be used since it excludes tactile examination from this level of inspection.*

**(2) General Visual Inspection (GVI).**

*A visual examination of an interior or exterior area, installation or*

*assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.*

Recent changes to this definition have added proximity guidance (within touching distance) and the allowance to use a mirror to enhance visual access to exposed surfaces when performing a GVI. These changes should result in more consistent application of GVI and support the expectations of what types of EWIS discrepancies should be detected by a GVI.

Though flashlights and mirrors may be required to provide an adequate view of all exposed surfaces, there is no requirement for equipment removal or displacement unless this is specifically called for in the access instructions. Paint and/or sealant removal is not necessary and should be avoided unless the observed condition is suspect. Should unsatisfactory conditions be suspected, items may need to be removed or displaced in order to permit proper assessment.

It is expected that the area to be inspected is clean enough to minimize the possibility that accumulated dirt or grease might hide unsatisfactory conditions that would otherwise be obvious. Any cleaning that is considered necessary should be performed in accordance with accepted procedures in order to minimize the possibility of the cleaning process itself introducing anomalies.

In general, the person performing a GVI is expected to identify degradation due to wear, vibration, moisture, contamination, excessive heat, aging, etc., and make an assessment as to what actions are appropriate to address the noted discrepancy. In making this assessment, any potential effect on adjacent system installations should be considered, particularly if these include wiring. Observations of discrepancies, such as chafing, broken clamps, sagging, interference, contamination, etc., need to be addressed.

### (3) Zonal Inspection.

*A collective term comprising selected General Visual Inspections and visual checks that are applied to each zone, defined by access and area, to check system and power plant installations and structure for security and general condition.*

A Zonal Inspection is essentially a GVI of an area or zone to detect obvious unsatisfactory conditions and discrepancies. Unlike a stand-alone GVI, it is not directed to any specified component or assembly.

**b. Guidance for Zonal Inspections.**

The following EWIS degradation items are typical of what should be detectable and subsequently addressed as a result of a zonal inspection (as well as a result of a stand-alone GVI). It is also recommended that these items be included in maintenance and training documentation. This list is not intended to be exhaustive and may be expanded as considered appropriate.

**(1) Wire / Wire Harnesses**

- Wire bundle/wire bundle or wire bundle/structure contact/chafing
- Wire bundle sagging or improperly secured
- Wires damaged (obvious damage due to mechanical impact, overheat, localized chafing, etc.)
- Lacing tape and/or ties missing/incorrectly installed
- Wiring protection sheath/conduit deformity or incorrectly installed
- End of sheath rubbing on end attachment device
- Grommet missing or damaged
- Dust and lint accumulation
- Surface contamination by metal shavings/swarf
- Contamination by liquids
- Deterioration of previous repairs (e.g., splices)
- Deterioration of production splices
- Inappropriate repairs (e.g., incorrect splice)
- Inappropriate attachments to or separation from fluid lines

**(2) Connectors**

- External corrosion on receptacles
- Backshell tail broken
- Rubber pad or packing on backshell missing
- No backshell wire securing device
- Foolproofing chain broken
- Missing or broken safety wire
- Discoloration/evidence of overheat on terminal lugs/blocks
- Torque stripe misalignment

**(3) Switches**

- Rear protection cap damaged

**(4) Ground points**

- Corrosion

**(5) Bonding braid/bonding jumper**

- Braid broken or disconnected
- Multiple strands corroded
- Multiple strands broken

(6) Wiring clamps or brackets

- Corroded
- Broken/missing
- Bent or twisted
- Faulty attachment (bad attachment or fastener missing)
- Unstuck/detached
- Protection/cushion damaged

(7) Supports (rails or tubes/conduit)

- Broken
- Deformed
- Fastener missing
- Missing edge protection on rims of feed through holes
- Racetrack cushion damaged
- Obstructed drainage holes (in conduits)

(8) Circuit breakers, contactors or relays

- Signs of overheating
- Signs of arcing

c. Wiring installations and areas of concern.

Research has shown that the following installations and areas need to be addressed in existing maintenance material.

(1) Wiring installations.

**Clamping points** – Wire chafing is aggravated by damaged clamps, clamp cushion migration, or improper clamp installations. Aircraft manufacturers specify clamp type and part number for EWIS throughout the aircraft. When replacing clamps use those specified by the aircraft manufacturer. Tie wraps provide a rapid method of clamping especially during line maintenance operations. Improperly installed tie wraps can have a detrimental effect on wire insulation. When new wiring is installed as part of a STC, field approval or other modification the drawings will provide wiring routing, clamp type and size, and proper location. Examples of significant wiring modifications are the installation of new avionics systems, new galley installations and new instrumentation. Wire routing, type of clamp and clamping location should conform to the approved drawings. Adding new wire to existing wire bundles may overload the clamps causing wire bundle to sag and wires to chafe. Raceway clamp foam cushions may deteriorate with age, fall apart, and consequently would not provide proper clamping.

**Connectors** – Worn environmental seals, loose connectors, missing seal plugs, missing dummy contacts, or lack of strain relief on connector grommets can compromise connector integrity and allow contamination to enter the connector, leading to corrosion or grommet degradation. Connector pin corrosion can cause overheating, arcing and pin-to-pin shorting. Drip loops should be maintained when connectors are below the level of the harness and tight bends at connectors should be avoided or corrected.

**Terminations** – Terminations, such as terminal lugs and terminal blocks, are susceptible to mechanical damage, corrosion, heat damage and contamination from chemicals, dust and dirt. High current-carrying feeder cable terminal lugs can over time lose their original torque value due to vibration. One sign of this is heat discoloration at the terminal end. Proper build-up and nut torque is especially critical on high current carrying feeder cable lugs. Corrosion on terminal lugs and blocks can cause high resistance and overheating. Dust, dirt and other debris are combustible and therefore could sustain a fire if ignited from an overheated or arcing terminal lug. Terminal blocks and terminal strips located in equipment power centers (EPC), avionics compartments and throughout the aircraft need to be kept clean and free of any combustibles.

**Backshells** – Wires may break at backshells, due to excessive flexing, lack of strain relief, or improper build-up. Loss of backshell bonding may also occur due to these and other factors.

**Sleeving and Conduits** – Damage to sleeving and conduits, if not corrected, may lead to wire damage. Therefore, damage such as cuts, dents and creases on conduits may require further investigation for condition of wiring within.

**Grounding Points** – Grounding points should be checked for security (i.e., finger tightness), condition of the termination, cleanliness, and corrosion. Any grounding points that are corroded or have lost their protective coating should be repaired.

**Splices** – Both sealed and non-sealed splices are susceptible to vibration, mechanical damage, corrosion, heat damage, chemical contamination, and environmental deterioration. Power feeder cables normally carry high current levels and are very susceptible to installation error and splice degradation. All splices should conform to the TC or STC holder's published recommendations. In the absence of published recommendations, environmental splices are recommended to be used.

(2) Areas of concern.

**Wire Raceways and Bundles** – Adding wires to existing wire raceways may cause undue wear and chafing of the wire installation and inability to maintain the wire in the raceway. Adding wire to existing bundles may cause wire to sag against the structure, which can cause chafing.

**Wings** – The wing leading and trailing edges are areas that experience difficult environments for wiring installations. The wing leading and trailing edge wiring is exposed on some aircraft models

whenever the flaps or slats are extended. Other potential damage sources include slat torque shafts and bleed air ducts.

**Engine, Pylon, and Nacelle Area** – These areas experience high vibration, heat, frequent maintenance, and are susceptible to chemical contamination.

**Accessory compartment and equipment bays** – These areas typically contain items such as electrical components, pneumatic components and ducting, hydraulic components and plumbing, and may be susceptible to vibration, heat, and liquid contamination.

**Auxiliary Power Unit (APU)** – Like the engine/nacelle area, the APU is susceptible to high vibration, heat, frequent maintenance, and chemical contamination.

**Landing Gear and Wheel Wells** – This area is exposed to severe external environmental conditions in addition to vibration and chemical contamination.

**Electrical Panels and Line Replaceable Units (LRUs)** – Panel wiring is particularly prone to broken wires and damaged insulation when these high density areas are disturbed during troubleshooting activities, major modifications, and refurbishments. Wire damage may be minimized by tying wiring to wooden dowels to reduce wire disturbance during modification. There may be some configurations where connector support brackets would be more desirable and cause less disturbance of the wiring than removal of individual connectors from the supports.

**Batteries** – Wires in the vicinity of all aircraft batteries are susceptible to corrosion and discoloration. These wires should be inspected for corrosion and discoloration. Discolored wires should be inspected for serviceability.

**Power Feeders** – High current wiring and associated connections have the potential to generate intense heat. Power feeder cables, terminals, and splices may be subject to degradation or loosening due to vibration. If any signs of overheating are seen, splices or termination should be replaced. Depending on design, service experience may highlight a need to periodically check for proper torque of power feeder cable terminal ends, especially in high vibration areas,. This applies to galley and engine/APU generator power feeders.

**Under Galleys, Lavatories, and Cockpit** – Areas under the galleys, lavatories, and cockpit, are particularly susceptible to contamination from coffee, food, water, soft drinks, lavatory fluids, dust, lint, etc. This contamination can be minimized by adherence to proper floor panel sealing procedures in these areas.

**Fluid Drain plumbing** – Leaks from fluid drain plumbing may lead to liquid contamination of wiring. In addition to routine visual inspections, service experience may highlight a need for periodic leak checks or cleaning.

**Fuselage Drain provisions** – Some installations include features designed to catch leakage that is plumbed to an appropriate exit. Blockage of the drain path can result in liquid contamination of wiring. In addition to routine visual inspections, service experience may highlight that these installations and associated plumbing should be periodically checked to ensure the drain path is free of obstructions.

**Cargo Bay/Underfloor** – Damage to wiring in the cargo bay underfloor can occur due to maintenance activities in the area.

**Wiring subject to movement** – Wiring that is subject to movement or bending during normal operation or maintenance access should be inspected at locations such as doors, actuators, landing gear mechanisms, and electrical access panels.

**Access Panels** – Wiring near access panels may receive accidental damage as a result of repetitive maintenance access and thus may warrant special attention.

**Under Doors** – Areas under cargo, passenger and service entry doors are susceptible to fluid ingress from rain, snow and liquid spills. Fluid drain provisions and floor panel sealing should be periodically inspected and repaired as necessary.

**Under Cockpit Sliding Windows** – Areas under cockpit sliding windows are susceptible to water ingress from rain and snow. Fluid drain provisions should be periodically inspected and repaired as necessary.

**Areas where wiring is difficult to access** – Areas where wiring is difficult to access (e.g., flight deck instrument panels, cockpit pedestal area) may accumulate excessive dust and other contaminants as a result of infrequent cleaning. In these areas it may be necessary to remove components and disassemble other systems to facilitate access to the area.

## 10. ENHANCED ZONAL ANALYSIS PROCEDURE.

The Enhanced Zonal Analysis Procedure (EZAP) identified in Appendix A of this AC is designed to permit appropriate attention to be given to electrical wiring installations. This is achieved by providing a means to identify applicable and effective tasks to minimize accumulation of combustible materials and address wiring installation discrepancies that may not otherwise be reliably detected by inspections contained in existing maintenance programs.

For aircraft models operating on maintenance programs that already include a dedicated Zonal Inspection Program (ZIP), the logic described in this AC will result in enhancements to those programs, and the zonal inspection requirements may not differ greatly from the existing ZIPs.

In analysis conducted under the EZAP, items such as plumbing, ducting, systems installations, etc.,

should be evaluated for possible contribution to wiring failures. In cases where a General Visual Inspection is required to assess degradation of these items, a Zonal GVI within a ZIP may be considered as appropriate.

For those operators that do not have a dedicated ZIP, application of the logic is likely to result in identification of a large number of wiring related tasks that will need to be consolidated within the existing Systems/Powerplant Program.

In either case, any new tasks identified by the logic may be compared with existing tasks and credit given for equivalent tasks already contained in the maintenance program. For operators with ZIPs that already contain Zonal GVIs, the number of new tasks that must be added to the program may be significantly fewer than for an operator without a dedicated ZIP. Therefore, operators without a ZIP may find it beneficial to develop a ZIP in accordance with an industry accepted methodology in conjunction with application of the EZAP.

The logic and procedures identified in this AC apply to TCs, STCs, and Service Bulletins. It is expected that the TC and STC holders would use the logic and procedures to identify any need for additional instructions for continued airworthiness. Operators may be required to use the logic to identify additional instructions for STCs where the STC has been “orphaned” (i.e., no longer supported by the STC holder).

While TC Holders are required to conduct the EZAP for all zones in an aircraft, it may be determined that EZAP for a Service Bulletin or STC is not necessary where the modification does not appreciably affect the zones where it is installed. Appendix C, “Determination if Service Bulletin Modification or STC Requires EZAP”, was developed to identify modifications that sufficiently affect zone attributes to warrant re-application of EZAP to the entire zone.

#### 11. MAINTENANCE PRACTICES: Protection and Caution Recommendations.

The FAA has identified some specific maintenance and servicing tasks for which more robust practices are recommended to be adopted by air carriers, air operators, maintenance providers, repair stations and persons performing field approvals. These recommendations apply to all tasks, including those performed on an unscheduled basis without an accompanying routine job instruction card. Performance of these maintenance practices will help prevent contamination of EWIS that result from contact with harmful solids (such as metal shavings) or fluids during maintenance, modifications, and repairs of airplane structures, and components. In addition the training of maintenance and servicing personnel should address the potential consequences of their actions on the wiring in the work vicinity.

- Item 1: Installation, repair, or modification to wiring.

Wiring and its associated components (protective coverings, connectors, clamping provisions,

conduits, etc.) often comprise the most delicate and maintenance sensitive portions of an installation or system. Extreme care should be exercised and proper procedures used during installation, repair, or modification of wiring to ensure safe and reliable performance of the function supplied by the wiring.

Proper wire selection, routing/separation, clamping configurations, use of splices, repair or replacement of protective coverings, pinning/de-pinning of connections, etc., should be performed in accordance with the applicable sections of the Aircraft Maintenance Manual (AMM), Wiring Practices Manual (WPM), or other documents authorized for maintenance use. In addition, special care should be taken to minimize disturbance of existing adjacent wiring during all maintenance activities. When wiring is displaced during a maintenance activity, special attention should be given to returning it to its normal configuration in accordance with the applicable maintenance instructions.

- Item 2: Structural repairs, STCs, modifications, field approvals.

Structural repair, STC, modification or field approval activity inherently introduces tooling and residual debris that is harmful to aircraft wiring. Structural repairs or modifications often require displacement (or removal) of wiring to provide access to the work area. Even minor displacement of wiring, especially while clamped, can damage wire insulation, which can result in degraded performance, arcing, or circuit failure.

Extreme care should be exercised to protect wiring from mechanical damage by tools or other equipment used during structural repairs, STCs, field approvals or modifications. Drilling blindly into the aircraft structure should be avoided. Damage to wire installation could cause wire arcing, fire and smoke. Wiring located adjacent to drilling or riveting operations should be carefully displaced or covered to reduce the possibility of mechanical damage.

Debris such as drill shavings, liberated fastener pieces, broken drill bits, etc., should not be allowed to contaminate or penetrate wiring or electrical components. This can cause severe damage to insulation and potential arcing by providing a conductive path to ground or between two (2) or more wires of different loads. Once contaminated, removal of this type of debris from wire bundles is extremely difficult. Therefore, precautions should be taken to prevent contamination of any kind from entering the wire bundle.

Before initiating structural repair, STC, field approval or modification activity, the work area should be carefully surveyed to identify all wiring and electrical components that may be subject to contamination. All wiring and electrical components in the debris field should be covered or removed to prevent contamination or damage. Consideration should be given to using drills equipped with vacuum aspiration to further minimize risk of metallic debris contaminating wire bundles. Clean electrical components and wiring after completion of work per applicable maintenance instructions.

- Item 3: Aircraft De-Icing or Anti-Icing.

To prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear, care should be exercised when spraying de/anti-icing fluids. Direct pressure spray onto electrical components and wiring can lead to contamination or degradation and thus should be avoided.

- Item 4: Inclement weather.

Electrical wiring interconnection systems in areas below doorways, floors, access panels, and servicing bays are prone to corrosion or contamination due to their exposure to the elements. Snow, slush, or excessive moisture should be removed from these areas before closing doors or panels. Remove deposits of snow/slush from any items (e.g., cargo containers) before loading in the aircraft. During inclement weather, keep doors/panels closed as much as possible to prevent ingress of snow, slush, or excessive moisture that could increase potential for EWIS degradation.

- Item 5: Component removal/installation (relating to attached wiring).

Excessive handling and movement during removal and installation of components may be harmful to aircraft wiring. Use appropriate connector pliers (e.g., soft jawed) to loosen coupling rings that are too tight to be loosened by hand. Alternately pull on the plug body and unscrew the coupling ring until the connector is separated. Do not use excessive force, and do not pull on attached wires. When reconnecting, special care should be taken to ensure the connector body is fully seated, the jam nut is fully secured, and no tension is on the wires.

When equipment is disconnected use protective caps on all connectors (plug or receptacle) to prevent contamination or damage of the contacts. Sleeves or plastic bags may be used if protective caps are not available. Use of sleeves or plastic bags should be temporary because of the risk of condensation. It is recommended to use a humidity absorber with sleeves or plastic bags.

- Item 6: Pressure Washing.

To prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear, care should be exercised when spraying water or cleaning fluids. Direct high-pressure spray onto electrical components and wiring can lead to contamination or degradation and should be avoided. When practical, wiring and connectors should be protected before pressure washing. Water rinse should be used to remove cleaning solution residue after washing. Breakdown of wire insulation may occur with long term exposure of wiring to cleaning solutions. Although these recommendations are good practice and technique, the airplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions regarding pressure washing.

- Item 7: Cleaning of electrical wiring interconnection systems (in situ).

Extreme care should be exercised and proper procedures used during cleaning to ensure safe and reliable performance of the function supplied by the wiring.

Care should be taken to avoid displacement or disturbance of wiring during cleaning of non-aggressive contamination. However, in the event of contamination by aggressive contaminants (e.g., livestock waste, salt water, battery electrolyte, etc.) such displacement may be necessary. In these cases wiring should be released from its installation so as to avoid undue stress being induced in wiring or connectors. Similarly, if liquid contamination enters the bundle then ties should be removed before separating the wires. Although these recommendations for cleaning of EWIS are considered good practice and technique, the airplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions.

Clean only the area and items that have contamination. Before cleaning, make sure that the cleaning materials and methods will not cause more contamination. If a cloth is used, make sure that it is clean, dry, and lint-free. A connector should be completely dry before mating. Any fluids remaining on a connector can have a deteriorating affect on the connector or the system or both.

- Item 8: Servicing, modifying, or repairing waste/water systems.

Electrical wiring interconnection systems in areas adjacent to waste/water systems are prone to contamination from those systems. Care should be exercised to prevent any fluids from reaching electrical components and wiring while servicing, modifying, or repairing waste/water systems. Cover exposed electrical components and wiring during waste/water system modification or repair. Operator practice may call for a weak acid solution to be periodically flushed through lavatory systems to enhance reliability and efficiency of operation. In view of the effect of acid contamination on systems and structure, the system should be confirmed to be free of leaks before using such solutions.

- Item 9: Servicing, modifying, or repairing oil systems.

Electrical wiring interconnections in areas adjacent to oil systems are prone to contamination from those systems. To minimize the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching electrical components and wiring while servicing, modifying, or repairing oil systems. Oil and debris in combination with damaged wiring can present a fire hazard.

- Item 10: Servicing, modifying, or repairing hydraulic systems.

Electrical wiring interconnection system in areas adjacent to hydraulic systems are prone to contamination from those systems. To minimize the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching electrical components and wiring while servicing, modifying, or repairing hydraulic systems.

- Item 11: Gaining access (entering zones).

When entering or working on the aircraft, care should be exercised to prevent damage to adjacent or hidden electrical components and wiring, including wiring that may be hidden from view (e.g., covered by insulation blankets). Use protective boards or platforms for adequate support and protection. Avoid using wire bundles as handholds, steps and supports. Work lights should not be hung or supported by wiring. If wiring must be displaced (or removed) for work area access, it should be adequately released from its clamping (or other restraining provisions) to allow movement without damage and returned after work is completed.

- Item 12: Application of Corrosion Prevention Compounds (CPC).

When applying CPC in airplane zones containing wire and associated components (i.e., clamps, connectors and ties), care should be taken to prevent CPC from coming in contact with the wire and components. Dust and lint is more likely to collect on wire that has CPC on it. Application of CPCs should be done in accordance with the aircraft manufacturer's recommendations.

## 12. ALTERATION.

The program to enhance EWIS maintenance also applies to EWIS installed, modified, or affected by operator alterations, STCs, or Field Approvals. Alterations that could affect EWIS include, but are not limited to, those that install new equipment in close proximity to wiring, introduce a heat source in the zone, or introduce potential sources of combustible material or harmful contamination into the zone.

The operator is responsible for determining if the EWIS has been altered (or affected by alteration) and enhancing the maintenance program as appropriate.

## 13. COMMENTS INVITED.

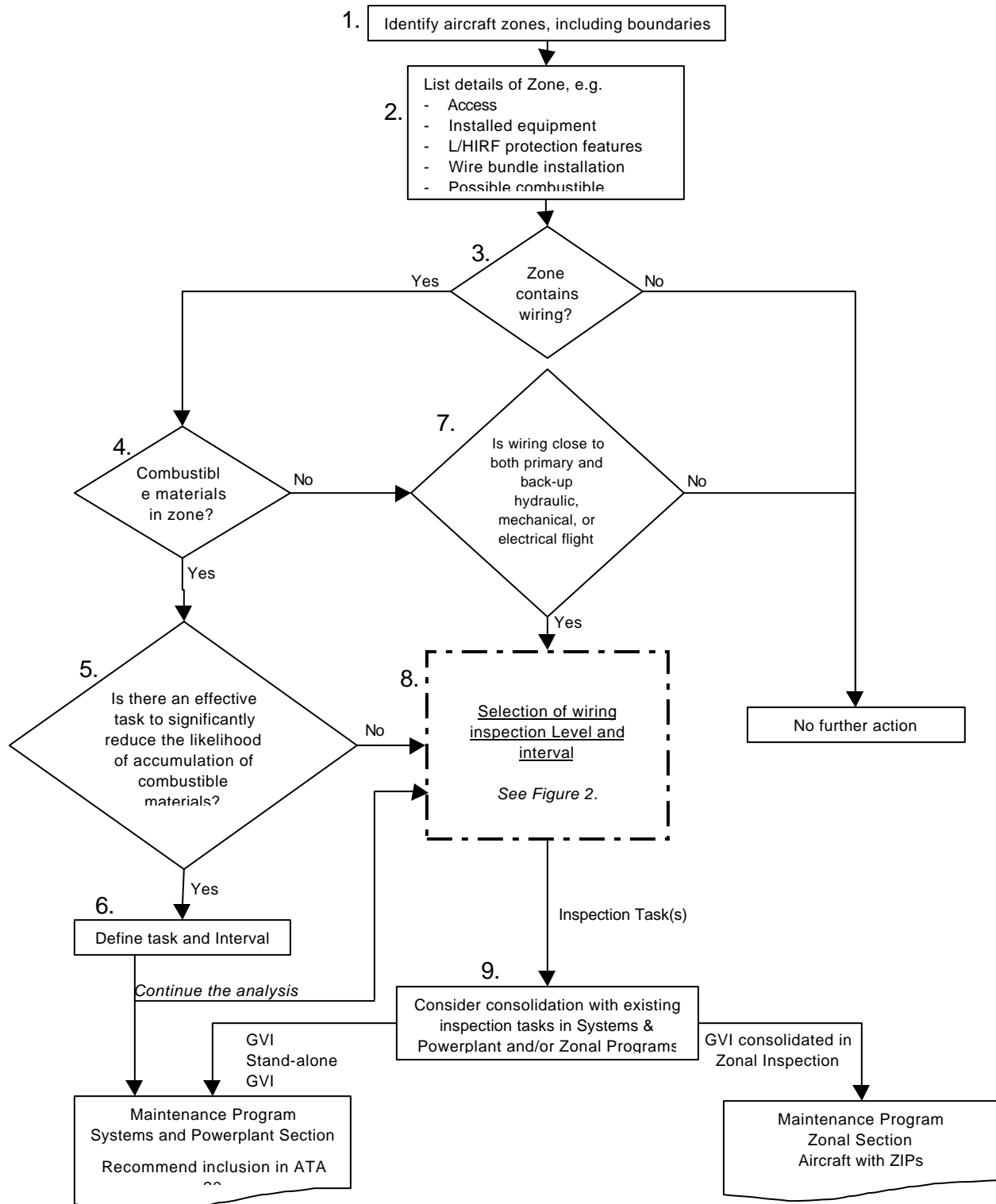
Comments regarding this Advisory Circular should be directed to the Continuous Airworthiness Maintenance Division, AFS-300, Flight Standards Service, Federal Aviation Administration, 800

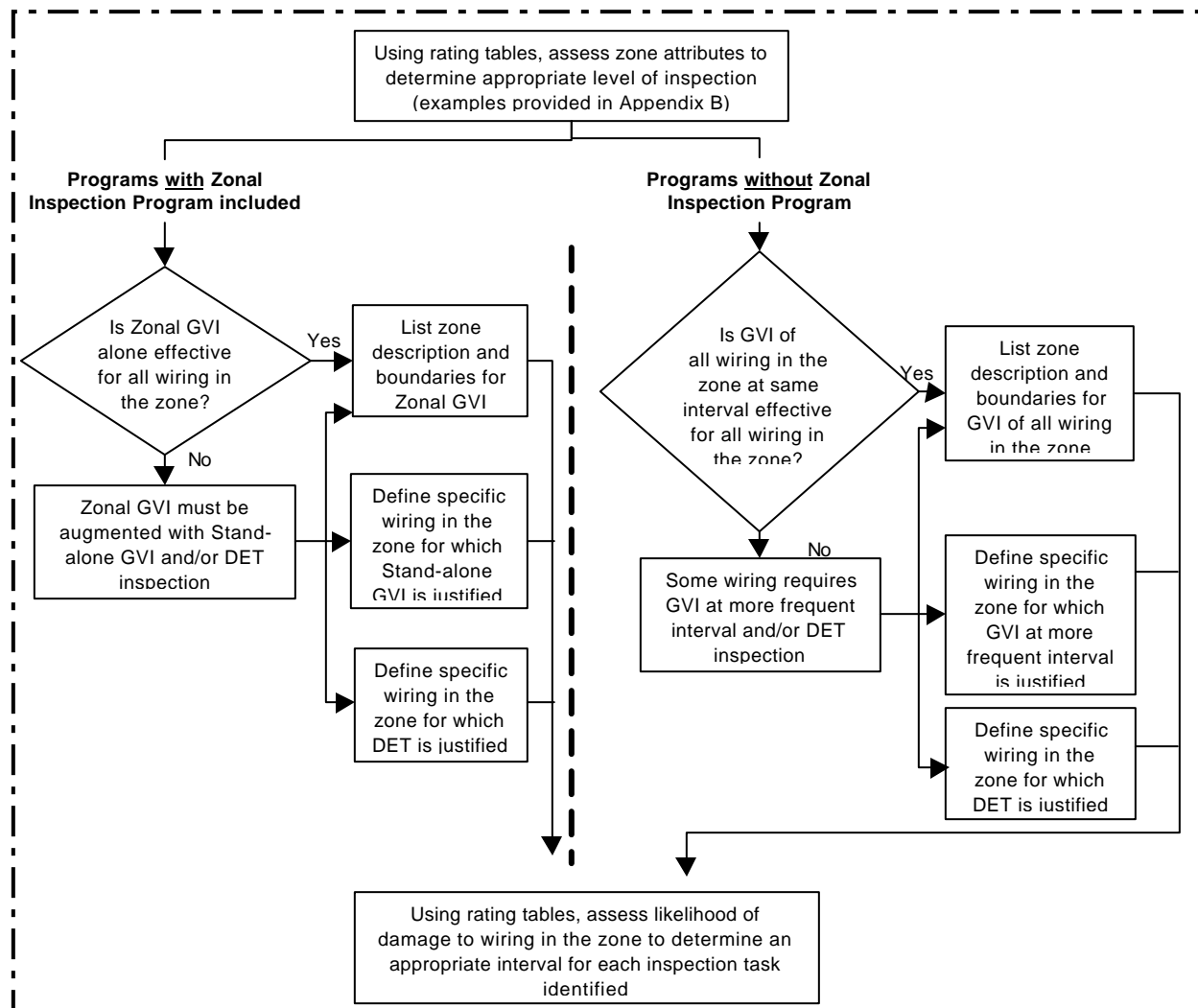
Independence Avenue, NW, Washington, DC, 20591, Attention: Mr. Fred Sobeck, AFS-304, phone (202) 267-7355.

James Ballough

Director, Flight Standards Service

## Appendix A. Enhanced Zonal Analysis Procedure Diagram

Figure 1. Enhanced Zonal Analysis Procedure

**Figure 2. Step 8 - Wiring Inspection Level and Interval Selection**

Explanation for Steps in Enhanced Zonal Analysis Procedure Logic Diagram. The following paragraphs provide further explanation of each step in the Enhanced Zonal Analyses Procedure logic, (Figures 1 and 2). It is recommended that, where possible, the analysts utilize the availability of actual aircraft to ensure they fully understand the zones being analyzed. This will aid in determination of density, size, environmental issues, and accidental damage issues.

Step 1. “Identify aircraft zones, including boundaries”

The system consists of Major Zones, Major Sub Zones and Zones.

The zones, wherever possible, shall be defined by actual physical boundaries such as wing spars, major bulkheads, cabin floor, control surface boundaries, skin, etc., and include access provisions for each zone.

If the type design holder or operator has not already established aircraft zones it is recommended that it do so. Whenever possible zones should be defined using a consistent method such as *ATA iSpec 2200* (formerly *ATA Spec 100*), varied only to accommodate particular design constructional differences.

Step 2. “List of details of zone”

An evaluation will be carried out to identify system installations, significant components, L/HIRF protection features, typical power levels in any installed wiring bundles, combustible materials (present or possible accumulation), etc.

With respect to power levels the analyst should be aware whether the bundle consists primarily of main generator feeder cables, low voltage instrumentation wiring or standard bus wiring. This information will later be used in determining the potential effects of deterioration.

The reference to combustible materials highlights the need to assess whether the zone might contain material/vapor that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include the possible presence of fuel vapors, dust/lint accumulation and contaminated insulation blankets. See also under Step 4 for further information.

For aircraft types whose design directives may not have excluded the possibility of inadequate segregation between systems, the analyst should identify locations where both primary and back-up flight controls are routed within 2 inches/50 mm of a wiring harness. This information is required to answer the question in Step 7.

Step 3. “Zone contains wiring?”

This question serves as a means to eliminate from the enhanced zonal analysis procedure those zones that do not contain any wiring.

Step 4. “Combustible materials in zone?”

This question requires an evaluation of whether the zone might contain combustible material that could cause a fire to be sustained in the event of an ignition source arising in adjacent wiring. Examples include the possible presence of fuel vapors, dust/lint accumulation, and contaminated insulation blankets.

With respect to commonly used liquids (e.g., oils, hydraulic fluids, corrosion prevention compounds) the analyst should refer to the product specification in order to assess the potential for combustibility. The product may be readily combustible only in vapor/mist form and thus an assessment is required to determine if conditions might exist in the zone for the product to be in this state.

Although liquid contamination of wiring by most synthetic oil and hydraulic fluids (e.g., skydrol) may not be considered combustible, it is a cause for concern if it occurs in a zone where it causes significant adherence of dust and lint.

The analyst should assess what sources of combustible products may contaminate the zone following any single failure considered likely from in-service experience. Unshrouded pipes having connections within the zone should be considered as potential contamination sources. Inherent ventilation in the zone should be taken into account when determining the potential for subsequent combustion. This influences the response to the question of how near to the harness the source should be for there to be a concern.

Avionics and instruments located in the flight compartment and equipment bays tend to attract dust, etc. In view of the heat generated by these components and the relatively tightly packed installations, the analyst should consider these zones as having potential for combustible material. Thus the enhanced logic should always be used for these zones.

**Note:** Although moisture (whether clean water or otherwise) is not combustible, it’s presence on wiring is a cause for concern because it may increase the probability of arcing from small breaches in the insulation which could cause a localized fire in the wire bundle. The risk of a sustained fire caused by moisture induced arcing is mitigated in Step 5 by identification of a task to reduce the likelihood of accumulation of combustible material on or adjacent to the wiring.

Step 5. “Is there an effective task to significantly reduce the likelihood of accumulation of combustible materials?”

Most operator maintenance programs have not included tasks directed towards removal or prevention of significant accumulations of combustible materials on or adjacent to wiring.

This question requires an evaluation of whether the accumulation on or adjacent to wiring can be significantly reduced. Task effectiveness criteria should include consideration of the potential for damaging the wiring.

Though restoration tasks (e.g., cleaning) are the most likely applicable tasks, the possibility to identify other tasks is not eliminated. A detailed inspection of a hydraulic pipe might be assessed as appropriate if high-pressure mist from pinhole corrosion could impinge a wire bundle and the inherent zone ventilation is low.

Step 6. “Define task and interval”

This step will define an applicable task and an effective interval. It should be included as a dedicated task in the Systems & Powerplant section. Within MRB Reports, this may be introduced under ATA 20 with no Failure Effect Category quoted.

It is not the intent that restoration tasks should be so aggressive as to damage the wiring, but should be applied to a level that significantly reduces the likelihood of combustion.

Step 7. “Is wiring close to primary and back-up hydraulic, mechanical, or electrical flight controls?”

Where wiring is close (i.e., within 2 inches/50 mm) to both primary and back-up hydraulic, mechanical, or electrical flight controls, this question is asked to ensure that Step 8 logic is applied even in the absence of combustible materials in the zone.

For zones where combustible materials are present (as determined in Step 4), proximity is addressed in the inspection level definition portion of Step 8 and this question need not be asked.

It addresses the concern that segregation between primary and back-up flight controls may not have been consistently achieved. Even in the absence of combustible material, a localized wire arcing could impact continued safe flight and landing if hydraulic pipes, mechanical cables, or wiring for fly-by-wire controls are routed in close proximity (i.e., within 2 inches/50 mm) to a wiring harness. In consideration of the redundancy in flight control systems, the question need be answered ‘Yes’ only if both the primary and back-up system might be affected by wire arcing. Note that in zones where a fire might be sustained by combustible material the enhanced logic will automatically be followed.

On all aircraft type designs, irrespective of TC date, modifications performed by STC holder, or field approvals may not have taken into account the TC holder’s design criteria. It is thus

recommended that STC holders assess their design changes with this question included in the logic unless they can demonstrate that they followed equivalent installation criteria. Similarly, air carriers and air operators will have to assess any field approvals or other modifications that have been accomplished on their aircraft.

Step 8. “Selection of Wiring Inspection Level and Interval”

a) Inspection Level.

At this point in the analysis, it is already confirmed that wiring is installed in a zone where the presence of combustible materials is possible and/or the wiring is in close proximity to primary and backup hydraulic or mechanical flight controls. Therefore, some level of inspection of the wiring in the zone is required, and this step details how the proper level of inspection and interval can be selected.

One method of selecting the proper inspection level and interval is through the use of ratings tables which rate attributes of the zone and how the wiring is affected by, or can affect those attributes. The precise format of this will be determined by the analyst, but example rating tables appear in Appendix B and may be referred to for clarity.

The Inspection Level characteristics that may be included in the rating system are:

- Zone size (volume).
- Density of installed equipment within the zone.
- Potential effects of fire on adjacent wiring & systems.

Zone size will be assessed relative to the size of the aircraft, typically identified as small, medium or large. The smaller the zone and the less congested it is, the more likely it is that wiring degradation will be identified by GVI.

Density of installed equipment, including wiring, within the zone will be assessed relative to the size of the zone. The density of the zone is typically identified as low, medium or high.

Potential effects of fire on adjacent wiring and systems requires the analyst to assess the potential effect of a localized fire on adjacent wiring and systems by considering the potential for loss of multiple functions to the extent that continued safe operation may not be possible.

Consideration of potential effect must also include whether wiring is in close proximity (i.e., within 2 inches/50 mm) to both primary and back-up flight controls. A GVI alone may not be adequate if a fire caused by failure of the wiring poses a risk to aircraft controllability.

At minimum, all wiring in the zone will require a GVI at a common interval. For operators with a Zonal Inspection Program, this may be defined as a Zonal GVI. For operators without ZIP, it

shall be defined as a GVI of all wiring in the zone.

The question is asked, "Is a GVI (or Zonal GVI) of all wiring in the zone at the same interval effective for all wiring in the zone?" This is to consider if there are specific items/areas in the zone that are more vulnerable to damage or contamination and thus may warrant a closer or more frequent inspection.

This determination could result in the selection of a more frequent GVI, a Stand-alone GVI (for operators with a ZIP), or even a DET inspection. The intention is to select a DET of wiring only when justified by consideration of all three characteristics of the zone (size, density, and potential effect of fire). The analyst should be cautious to avoid unnecessary selection of DET where GVI is adequate. Over-use of DET dilutes the effectiveness of the inspection.

**Note:** The level of inspection required may be influenced by tasks identified in Steps 5 and 6. For example, if a cleaning task was selected in Step 5 and 6 that will minimize the accumulation of combustible materials in the zone, this may justify selection of a GVI in lieu of a DET for the wiring in the zone.

b) Inspection Interval.

The selection of an effective interval can also be accomplished using a rating system. The characteristics for wiring to be rated should include the following:

- Possibility of Accidental Damage.
- Environmental factors.

The rating tables should be designed to define increasing inspection frequency with increasing risk of accidental damage and increasing severity of the local environment within the zone. Examples are provided in Appendix E.

The selection of inspection tasks possible in this step is specific to whether the maintenance program includes a dedicated Zonal Inspection Program or not.

For ZIP programs, the possible inspection tasks are:

- ? Zonal GVI
- ? Stand-alone GVI
- ? DET

For non-ZIP programs, the possible inspection tasks are:

- ? GVI
- ? DET

**Note:** At this point the analyst will have determined the required inspection level and interval

for wiring in the zone. Task consolidation in Step 9 allows consideration as to whether an inspection selected as a result of this analysis can be considered accomplished as part of the existing maintenance program.

Step 9. “Task Consolidation”

This step in the procedure examines the potential for consolidation between the tasks derived from the Enhanced Zonal Analysis Procedure and inspections that already exist in the Maintenance Program. Consolidation requires that the inspections in the existing maintenance program are performed in accordance with the inspection definitions provided in this AC.

For programs that include a Zonal Inspection Program (ZIP):

Some GVIs identified by application of the Enhanced Zonal Analysis Procedure may be adequately covered by existing Zonal GVIs in the zone and no change or addition to the existing Zonal GVI is required. This should reduce the number of new GVIs that must be introduced into a program that already includes a ZIP.

The consolidation of GVI tasks has to take into account the access requirements and the interval of each task. The Working Group may conclude that a stand-alone GVI of the wiring may be justified if the Zonal GVI of the other systems within the same zone does not need to have such a frequent inspection.

Stand-alone GVIs and DETs identified by application of EZAP cannot be consolidated into the Zonal Inspection Program and must be introduced and retained as dedicated tasks in the scheduled maintenance program under ATA 20. These tasks, along with tasks identified to reduce the accumulation of combustible materials, shall be uniquely identified to ensure they are not consolidated in the zonal program nor deleted during future program development. Within MSG-3 based MRB Reports, these may be introduced under ATA 20 with no Failure Effect Category quoted.

For programs without a Zonal Inspection Program (ZIP):

Although non-ZIP programs may already include some dedicated inspections of wiring that may be reviewed for equivalency to new tasks identified by application of the Enhanced Zonal Analysis Procedure, it is expected that a significant number of new wiring inspections will be identified for introduction as dedicated tasks in the System & Powerplant program. All new tasks identified by application of EZAP shall be uniquely identified to ensure they are not deleted during future program development.

The following guide can be used to determine proper consolidation between EZAP derived inspections and existing inspections of the same item or area with the caveat that EZAP Stand-alone GVIs and DETs cannot be consolidated into a Zonal GVI. Where a task is selected to

be consolidated, the program documentation must include a record identifying the task which has been consolidated for traceability purposes.

- a) Where the EZAP inspection interval and existing inspection interval are equal, but the inspection levels are different, the more intense inspection will take precedent (i.e., a 1C DET takes precedent over a 1C GVI).
- b) Where the EZAP inspection interval and existing inspection interval are different, but the inspection levels are equal, the more frequent inspection will take precedent (i.e., a 1C GVI takes precedent over a 2C GVI).
- c) Where the EZAP inspection interval and level are different than the existing inspection interval and level, these tasks may be consolidated only when the more frequent inspection is also the more intense (i.e., a 1C DET takes precedent over a 2C GVI). When the more frequent inspection is less intense, the tasks should not be consolidated.

For all programs, EZAP stand-alone tasks shall be uniquely identified in the program documentation for traceability during future changes to the program. This is intended to prevent the inadvertent deletion or escalation of EZAP stand-alone tasks without proper consideration of the basis for the task and its interval.

For EZAP derived STC tasks, it may not be possible for the STC holder to determine whether a ZIP exists on specific aircraft that will utilize the STC. Therefore, where a ZIP exists, consolidation of EZAP derived STC tasks into a specific operator's ZIP will be the responsibility of the operator and subject to approval by the cognizant FAA PMI.

In cases where the STC holder determines a requirement for a GVI that should not be consolidated into a ZIP, this Stand-alone GVI should be specifically identified as such in the EZAP derived ICAW for the STC.

## Appendix B. Examples of Typical EZAP Worksheets

The following worksheets are provided as an example to assist in application of the EZAP logic. The worksheets may be adjusted by the analyst to suit specific applications.

Sheet 1     Details of Zone

Sheet 2     Assessment of Zone Attributes

Sheet 3A    Inspection Level Determination based on Rating Tables (for use where a dedicated Zonal Inspection Program exists)

Sheet 3B    Inspection Level Determination based on Rating Tables (for use where no dedicated Zonal Inspection Program exists)

Sheet 4     Interval Determination based on Rating Tables

Sheet 5     Task Summary

Note: The interval ranges quoted in the rating table on Sheet 4 are solely to explain a typical arrangement of values. For a particular application, these must be compatible with the interval framework used in the existing maintenance or inspection program. They may be expressed in terms of usage parameter (e.g., flight hours or calendar time) or in terms of letter check (as in the example).

For this report, the worksheets have been electronically pasted into this section. FAA is in possession of the source files that can be reformatted as necessary to achieve the level of quality required for distribution to industry review for review.

### Enhanced Zonal Analysis - Details of Zone

Sheet 1 of 5

ZONE NO:		ZONE DESCRIPTION:	
1. Zone Details (Boundaries, Access):			
2. EQUIPMENT INSTALLED		COMMENTS	
<input type="checkbox"/>	Hydraulic Plumbing	<p><i>This sheet is used to comply with Steps 1 and 2 of the Enhanced Zonal Analysis Procedure:</i></p> <p><i>1. Describe the zone (location, access, boundaries)</i></p> <p><i>2. List the content of the zone; installed equipment, wiring, plumbing, components, etc.</i></p> <p><i>In the comments section on this sheet, it would be appropriate to note significant wire related items such as "Wire bundle routed within 2" of high-temp anti-ice ducting". The intent is to provide the analyst with a clear understanding of what's in the zone and how it could potentially affect wiring.</i></p>	
<input type="checkbox"/>	Hydraulic Components (valves, actuators, pumps)		
<input type="checkbox"/>	Pneumatic Plumbing		
<input type="checkbox"/>	Pneumatic Components (valves, actuators)		
<input type="checkbox"/>	Electrical Wiring - Power Feeder (high voltage, high amperage)		
<input type="checkbox"/>	Electrical Wiring - Motor Driven Devices		
<input type="checkbox"/>	Electrical Wiring - Instrumentation, and Monitoring		
<input type="checkbox"/>	Electrical Wiring - Data Bus		
<input type="checkbox"/>	Electrical Components		
<input type="checkbox"/>	Primary Flight Control Mechanisms		
<input type="checkbox"/>	Secondary Flight Control Mechanisms		
<input type="checkbox"/>	Engine Control Mechanisms		
<input type="checkbox"/>	Fuel Components		
<input type="checkbox"/>	Insulation		
<input type="checkbox"/>	Oxygen		
<input type="checkbox"/>	Potable Water		
<input type="checkbox"/>	Waste Water		

Sample EZAP Worksheet

Date:

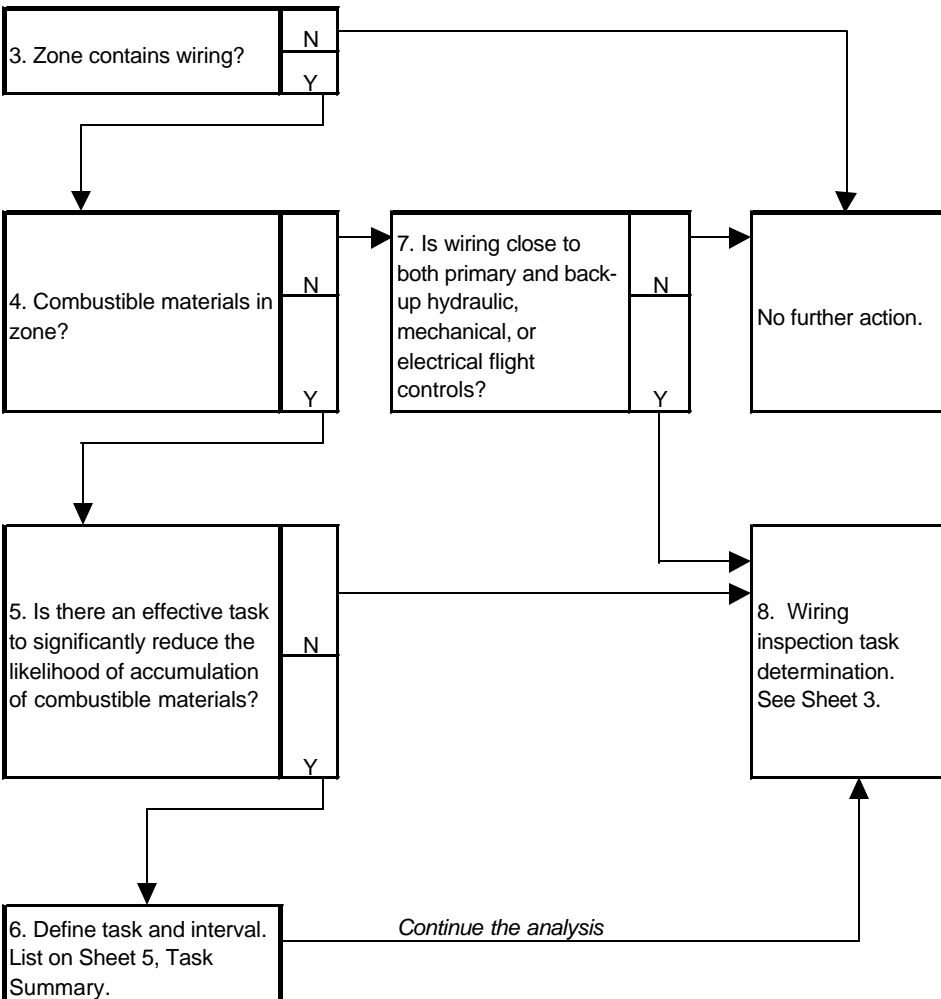
Page 1 of 5

## Enhanced Zonal Analysis - Assessment of Zone Attributes

Sheet 2 of 5

ZONE NO:      ZONE DESCRIPTION:

Steps 1 and 2 completed on Sheet 1.

**Answers and Explanation to Questions**

(Note: Steps 1 &amp; 2 completed on Sheet 1.)

3. This sheet is used to answer Questions 3 thru 7 of the Enhanced Zonal Analysis Procedure.
4. If the answer to Questions 3 and 7 is 'NO', then no further action is required in this analysis which is designed to address only wiring systems.
5. If the answer to Question 5 is 'YES', and a task is identified that can significantly reduce the likelihood of accumulation of combustible materials, the task and interval must be defined in Step 6. If the task identified is a cleaning task to remove dust/lint accumulation from wiring, the interval for the task must be frequent enough to keep the wiring relatively clean based on the expected rate of accumulation of dust/lint on the wiring in the zone.
6. In all cases, after Step 5 and/or Step 6, the analysis is continued to Step 8.
- 7.

## Enhanced Zonal Analysis - Inspection Level Determination based on Zone Size, Density, Potential Impact of Fire

Sheet 3A of 5

## For Programs with dedicated Zonal Inspection Program (ZIP)

ZONE NO: ZONE DESCRIPTION

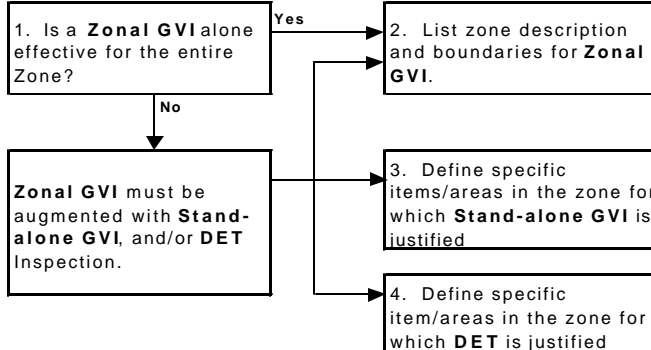
Zone Size/Density Assessment				
		Zone Size		
		Small	Medium	Large
Density	Low	1	2	3
	Medium	2	2	3
	High	2	3	3

Circle appropriate result and insert below.

RESULT: 

Inspection Level Determination Based on Potential Effect of Fire in Zone				
Size/Density Factor		1	2	3
Potential Effects of Fire in Zone	Low	Zonal GVI	Zonal GVI	Zonal GVI
	Medium	Zonal GVI	Zonal GVI + Stand-alone GVI of some wiring	Zonal GVI + Stand-alone GVI of some wiring
	High	Zonal GVI + Stand-alone GVI of some wiring	Zonal GVI + Stand-alone GVI and/or DET of some wiring	Zonal GVI + Stand-alone GVI and/or DET of some wiring

Circle appropriate result and answer questions in Boxes below.



If answer to Box 1 is 'Yes', answer Box 2 only.  
 If answer to Box 1 is 'No', answer Boxes 2, 3, & 4.

## Answers &amp; Explanation:

- The tables on this Sheet are used to select the appropriate level of inspection for the wiring in the zone based on an assessment of zone size, density, and potential effects of fire in the zone.  
  
This worksheet is designed for operators whose existing maintenance program already includes a dedicated Zonal Inspection Program. It is assumed that an existing ZIP already includes a Zonal GVI of all zones that contain wiring, and that the wiring is included in the Zonal GVI.
- The minimum outcome of this analysis will always be a Zonal GVI of any zone where the presence of combustible materials is possible and/or wiring is located in close proximity to both primary and backup hydraulic or mechanical flight controls.
- The Inspection Level Determination Table allows the Analyst to determine if a Zonal GVI alone is adequate for all wiring in the zone, or if the Zonal GVI must be augmented with a Stand-alone GVI and/or a DET inspection of some portion of the wiring.
- If a Zonal GVI is adequate for all wiring in the zone, the analyst must identify the inspection area as the zone itself (Box 2). Interval selection will be made on Sheet 4.  
  
If a Zonal GVI is not adequate for all wiring in the zone, in addition to identifying the Zonal GVI (Box 2), the analyst must also identify the specific items/areas in the zone where a Stand-alone GVI (Box 3) and/or a DET inspection (Box 4) is justified.  
  
Note: While it is useful to know the existing Zonal GVI interval while conducting this analysis, it is not assumed that the Zonal GVI interval selected during this analysis with respect to wiring will be the same as the existing interval. During task consolidation after completion of the analysis, the most frequent Zonal GVI interval for the zone will take precedent.

## Enhanced Zonal Analysis - Inspection Level Determination based on Zone Size, Density, Potential Impact of Fire

Sheet 3B of 5

## For Programs without dedicated Zonal Inspection Program (ZIP)

ZONE NO:      ZONE DESCRIPTION:

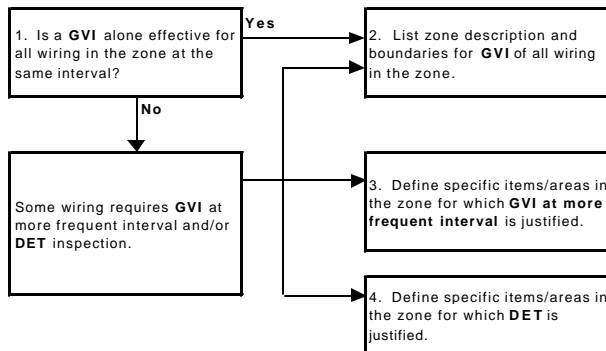
Zone Size/Density Assessment				
		Zone Size		
		Small	Medium	Large
Density	Low	1	2	3
	Medium	2	2	3
	High	2	3	3

Circle appropriate result and insert below.

RESULT:      

Inspection Level Determination Based on Potential Effect of Fire in Zone				
Size/Density Factor		1	2	3
Potential Effects of Fire in Zone	Low	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval
	Medium	GVI of all wiring in zone at same interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval
	High	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval and/or DET of some wiring	GVI of all wiring in zone at same interval + GVI of some wiring at more frequent interval and/or DET of some wiring

Circle appropriate result and answer questions in Boxes below.



If answer to Box 1 is 'Yes', answer Box 2 only. If answer to Box 1 is 'No', answer Boxes 2, 3, & 4.

## Answers &amp; Explanation:

1. The tables on this sheet are used to select an Inspection Level based on zone size, density, and potential effect of fire in the zone. These factors are used to determine if a GVI of all wiring in the zone at the same interval is adequate, or if some wiring requires a more frequent GVI, or even a DET inspection.
2. This worksheet is designed for operators whose existing maintenance program does not include a dedicated Zonal Inspection Program. The minimum outcome of this analysis will always be a GVI of all wiring in any zone where the presence of combustible materials is possible and/or wiring is located in close proximity to both primary and backup hydraulic or mechanical flight controls.
3. If a GVI of all wiring in the zone at the same interval is adequate, the analyst must identify the inspection requirement as "GVI of all wiring in the zone" (Box 2) and proceed to Sheet 4 to determine the GVI interval.
4. If a GVI of all wiring in the zone at the same interval is not adequate, then the analyst must identify the specific items/areas in the zone where a more frequent GVI (Box 3) and/or a DET inspection (Box 4) is justified.

## Enhanced Zonal Analysis - Interval Determination Based on Hostility of Environment and Likelihood of Accidental Damage

Sheet 4 of 5

ZONE NO:

ZONE DESCRIPTION:

Interval selection is specific to each task identified on Sheet 3A or 3B. For GVI of entire zone, consider overall zone environment and likelihood of damage. For Stand-alone GVI or DET, consider environment and likelihood of damage only in respect to the specific item/area defined for inspection.

Item/Area Defined for Inspection:

Inspection Level:

Hostility of Environment	
1 - Passive 2 - Moderate 3 - Severe	
Temperature	
Vibration	
Chemicals (toilet fluids, etc.)	
Humidity	
Contamination	
Other -	
Highest Result	

Likelihood of Accidental Damage	
1 - Low 2 - Medium 3 - High	
Ground Handling Equipment	
F.O.D.	
Weather Effects (hail, etc.)	
Frequency of Maintenance Activities	
Fluid Spillage	
Passenger Traffic	
Other -	
Highest Result	

Interval Determination				
		Likelihood of Accidental Damage		
		1	2	3
Hostility of Environment	1	4C-6C	2C-4C	1C-2C
	2	2C-6C	1C-4C	A-1C
	3	1C-6C	1C-4C	A-1C

RESULT	
--------	--

Upon completion, enter all task and interval selections onto Sheet 5, Task Summary.

Enhanced Zonal Analysis - Task Summary				Sheet 5 of 5
ZONE NO:		ZONE DESCRIPTION:		
Zone Description:				
TASK SUMMARY				
Task Number	Access	Interval	Task Description	
			<div>This Sheet is used to list all tasks and intervals selected as a result of EZAP analysis.</div>	
Sample EZAP Worksheet				
		Date:		Sheet 5 of 5

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**Appendix C: Determination If Service Bulletin Modification or STC Requires EZAP**

The EZAP provides a means for TC and STC Holders to develop improvements to EWIS maintenance programs. These improvements will be in the form of new inspections and other tasks designed to prevent significant accumulation of combustible materials on or adjacent to EWIS components that would be added to the *Instructions for Continued Airworthiness* or Service Bulletins (SBs) for the aircraft and STC's.

While TC Holders are required to conduct the EZAP for all zones in an aircraft, it may be determined that EZAP for an SB or STC is not necessary where the modification does not appreciably affect the zones where it is installed. The "Determination if Service Bulletin Modification or STC Requires EZAP" procedure was developed to identify modifications that sufficiently affect zone attributes to warrant re-application of EZAP to the entire zone.

This logic assumes that the aircraft TC holder has accomplished the EZAP on each zone of the aircraft without consideration of the SB modification or STC installation. The objective of this analysis is to assess whether the modification itself has affected wiring or certain zone attributes that could change the outcome of the EZAP performed by the aircraft type certificate holder.

The determination if the SB or STC requires EZAP, and re-application of the EZAP to SB or STC affected zones, is the responsibility of the respective Holder of the SB or STC. It is expected that the TC and STC Holders will collaborate with each other and Operators as necessary to obtain information required to conduct the analysis. The TC or STC Holder should communicate the results of the procedure, including when no new tasks are identified. The method of communication may be via Service Bulletin, Service Letter, ICAW Revision, or other means acceptable to the FAA.

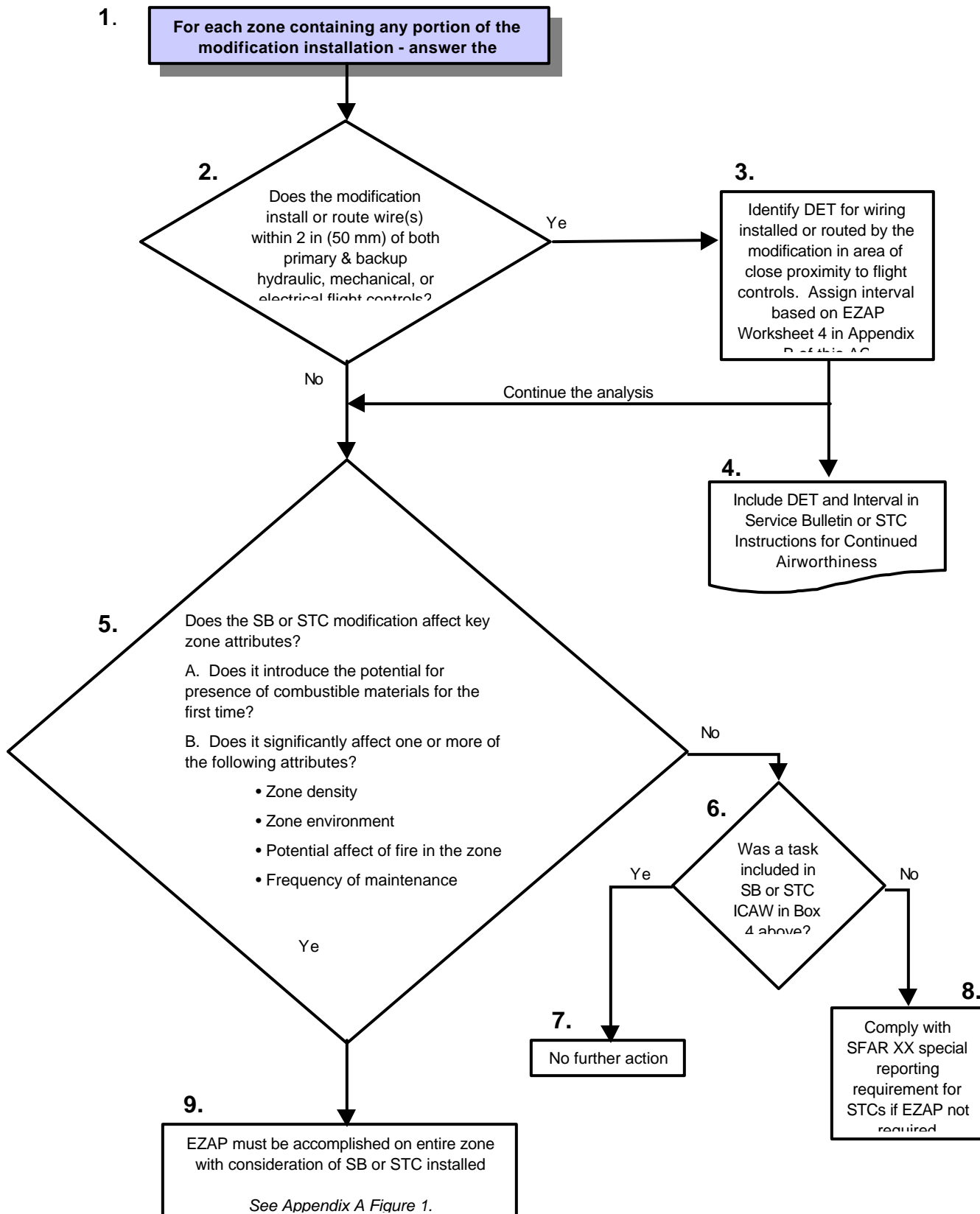
In situations where a previously installed STC is no longer supported by a viable STC Holder (e.g., STC Holder defunct), the responsibility for determining if the STC requires EZAP, and re-application of EZAP to any affected zones, is assigned to the individual operators who utilize the STC on their aircraft. In cases where the operator does not have experience in application of analytical logic processes, it will be necessary for the operator to gain competence in, or seek external assistance in conducting the analysis.

A record of the outcome of Operator accomplished analysis for STC's (even if no tasks are identified) should be permanently retained by the Operator. A copy of the record should be included in the aircraft records normally transferred upon change of aircraft operator.

The attached logic chart provides a means to assess whether an SB modification or STC has sufficiently affected wiring or certain other zone attributes as to require reapplication of the EZAP to the entire zone with consideration of the modification present. The section following the chart provides detailed explanations of each step in the Determination If Service Bulletin Modification or STC Requires EZAP with appropriate examples.

It is recommended that where possible, the analyst should utilize the availability of actual aircraft to ensure they fully understand the zones being analyzed. Specifically, it must be determined how installation of the modification could affect zone attributes such as density, environment, proximity of wiring to primary and backup flight controls, presence of combustible materials, and potential for accidental damage to wiring.

**Appendix C. Figure 1. Determination if Service Bulletin Modification  
or STC Requires EZAP**



**Determination If Service Bulletin Modification or STC Requires EZAP****Explanation of Steps**

Step 1. "For each zone containing any portion of the modification installation - answer the following."

Using the aircraft manufacturer's zone identification system (typically, zone numbers), identify all zones where any portion of the modification is installed, including non-wiring portions such as plumbing, ducting, cables, etc.

For each zone containing any portion of the modification, perform the following Steps:

Step 2. "Does the modification install or route wire(s) within 2 in (50 mm) of both primary & backup hydraulic, mechanical, or electrical flight controls?"

This questions addresses the concern that segregation between primary and back-up flight controls may not have been consistently achieved in the aircraft design. Even in the absence of combustible material, a localized arc emanating from wiring could impact continued safe flight and landing if the wiring is within 2 inches/50 mm of hydraulic, mechanical, or electrical flight controls. In consideration of the redundancy in flight control systems, the question need be answered 'Yes' only if both the primary and back-up system might be affected by an arc from the wiring installed or routed by the modification.

If the answer to Step 2 is 'NO', bypass Steps 3 and 4 and proceed to Step 5.

If the answer is 'YES', proceed to Step 3.

Step 3. "Identify DET for wiring installed or routed by the modification in area of close proximity to flight controls. Assign interval based on Appendix C, Figure 2."

Wiring installed or routed within 2 inches / 50 mm of both primary and backup flight controls will require a DET. The TC or STC Holder must identify the specific wiring for DET and use the worksheet in Figure 2 to determine the required interval. The DET and interval must be added to the SB instructions or the STC Instructions for Continued Airworthiness in accordance with Part 25, Appendix H.

Step 4. "Include DET and Interval in Service Bulletin or STC Instructions for Continued Airworthiness."

The DET and interval identified in Step 3 must be added to the SB instructions or the STC Instructions for Continued Airworthiness.

After completion of Step 3 (and 4, if applicable), continue the analysis and proceed to Step 5.

Step 5. “Does the SB or STC modification affect key zone attributes?”

This step consists of multiple questions to determine if the modification has affected certain zone attributes that could change the outcome of the EZAP applied to the zone without the modification installed. A ‘YES’ answer to any of the questions will require reapplication of EZAP to the entire zone.

- A. Does it introduce the potential for presence of combustible materials in the zone for the first time?

This question assesses whether the modification could, by design, or failure of a single item, introduce combustible materials onto or adjacent to wiring in the zone for the first time. If yes, the full EZAP must be accomplished on the zone.

Example 1:

The modification installs a “tee” fitting in a fuel pressure line to support a new fuel pressure indication system. Prior to the modification, the fuel line transited the zone with no connections or couplings in the zone that could be potential leak sources, and the zone had no other potential sources of combustible materials. In this example, the answer to the question would be ‘YES’ – the newly installed “tee” fitting introduces a potential source of combustible materials in the zone for the first time.

Example 2:

The modification installs a “tee” fitting in a fuel pressure line to support a new fuel pressure indication system. The “tee” is installed at an existing coupling in the line. In this example, the answer to the question would be ‘NO’ because the potential for a fuel leak already existed at the fuel line connection already present in the zone.

- B. Does it significantly affect one or more of the following zone attributes?

- 1) Zone density
- 2) Zone environment
- 3) Potential effect of fire in the zone
- 4) Frequency of maintenance access to the zone

The zone attributes listed here are considered in the EZAP performed by the aircraft TC Holder and are rated (e.g., low, medium, or high) as part of the determination of wiring inspection levels (GVI or DET) and their intervals. For example, the TC Holder could conclude that a high-density zone with an environment hostile to wiring warrants more intense and/or more frequent inspections than wiring in a less dense or hostile zone. The question is asked here assess whether the modification significantly affects any of these attributes which would require a re-

analysis of the entire zone.

- Zone density – Does the modification affect zone density? If the modification includes the addition or deletion of numerous components in a small area, the density of the zone could be changed. A significant change in zone density should warrant re-analysis of the zone.
- Zone environment – Does the modification have an effect on zone environment? For example, if the modification installs a new hot-air duct in a zone that could significantly increase the ambient temperature of the zone during any phase of operation (including ground operations), re-analysis of the zone is required.
- Potential effect of fire in the zone – Does the modification significantly change the potential effect of a localized fire on adjacent wiring and systems? This question considers the potential for loss of multiple functions to the extent that continued safe operation may not be possible.

#### Example 1

The modification installs new Terrain Awareness Warning System wiring adjacent to existing wiring associated with primary flight instrumentation. This modification could increase the potential effect of a fire in the zone by the adding TAWS to the multiple systems contained within a single wire bundle that could be lost due to a localized arc or fire. Thus the answer to the question is “YES.”

#### Example 2

The modification replaces existing analog flight instrumentation with new digital displays that include replacement of a single, large, multi-function wire bundle with separately routed wire bundles for the Pilot and Co-Pilot flight displays. This modification reduces the potential effect of a fire in the zone by providing greater separation of wiring for primary flight instruments. In this example, the answer is “YES,” with the possibility that re-application of EZAP to the entire zone may determine that GVI rather than DET is adequate for the wiring in the zone after modification.

- Frequency of maintenance access to the zone – Does the modification change the frequency of maintenance access to the zone? More frequent access to a zone offers greater potential for accidental damage to wiring in the zone. To properly answer this question, the Analyst should collaborate with the TC Holder and current operators to determine typical frequency of maintenance access to the zone.

#### Example 1

The modification installs a new cargo door system that includes installation of a hydraulic accumulator. The SB instructions or STC Instructions for Continued Airworthiness (required by Part 25, Appendix H), include a servicing of the accumulator at 2A interval. The TC Holder (or Operator) maintenance program accesses the zone at 1C

interval. In this case, the answer is “YES” as the modification does change the frequency of maintenance access to the zone.

If the modification significantly affects any of the zone attributes noted, re-analysis of the zone is required and the analysis continues to Step 9. If the modification does not affect these attributes, the analysis continues to Step 6.

**Step 6.** “Was a task included in SB or STC ICAW in Box 4 above?”

This question is asked to determine whether special reporting for STCs is required. SFAR XX requires special reporting for STCs approved prior to [insert date 24 months after effective date] to document compliance with EZAP requirements when no tasks are identified. If a task was identified in Step 4, the reporting requirement is satisfied by inclusion of the task in the STC ICAW. This requirement does not apply to SBs.

**Step 7.** “No further action.”

Analysis is complete and no special reporting is required.

**Step 8.** “Comply with SFAR XX special reporting requirement for STCs if EZAP not required.”

If the answer to Step 6 is ‘NO’, SFAR XX requires special reporting to FAA and operators for STCs approved prior to [insert date 24 months after effective date] to document compliance with EZAP requirements when no tasks are identified.

**Step 9.** “EZAP must be accomplished on entire zone with consideration of the SB or STC installed.”

At this point, the analyst has determined that the modification could have affected certain zone attributes that may alter the outcome of the EZAP conducted by the TC Holder without regard to the presence of the modification. The full EZAP must be applied to the zone with consideration of the modification present.

It is possible that application of the EZAP may result in no new tasks identified. Upon completion of the EZAP, SFAR-XX requires special reporting for STCs approved prior to [insert date 24 months after effective date] to document compliance with EZAP requirements when no tasks are identified.

## Appendix D. Electrical Wiring Interconnection System

***Note: Prior to publication, FAA will update this section to reflect final version of EWIS definition from ATSRAC Task 6 Harmonized Working Group.***

As stated in the definitions section of this Advisory Circular “Electrical Wiring Interconnection System” (EWIS) is defined as follows:

“An electrical connection between two or more points including the associated termination devices (e.g., connectors, terminal blocks, splices) and the necessary means for its installation and identification.”

The definition of “EWIS” includes the following:

- Wires (e.g., wire, cable, coax, databus, feeders, ribbon cable).
- Bus bars.
- Connection to electrical devices (e.g., relays, push button, interrupters, switches, contactors, terminal blocks, feed-through connectors).
- Circuit breakers or other circuit protection devices (not performance).
- Electrical contacts.
- Connector and accessories (e.g., backshell, sealing boot grommet sealing plugs).
- Electrical grounding and bonding devices (e.g., modules, straps, studs).
- Electrical splices.
- Shield or braids.
- Conduits that have electrical termination.
- Clamps and other devices used to route and support the wire bundle.
- Cable tie devices.
- Labels or other means of identification methods.
- Pressure seals associated with EWIS.
- Wiring inside shelves, panels, racks, junction boxes, distribution panels, back-planes of equipment racks (including circuit board back-planes), wire integration units, etc.

The following wires and devices (along with the mating connections at the termination points of the wire on those devices) are not considered part of the “EWIS”:

- Wiring inside avionics equipment (e.g., flight management system computer, flight data recorder, VHF radio, primary flight display).
- Equipment qualified to the standards of RTCA Document DO-160 or shown to be equivalent (other than those specifically included in this definition).
- Equipment qualified to a technical standard order (TSO).
- Portable, carry on, or otherwise non-permanently mounted (not part of the certification basis) electrical equipment.
- Fiber optics.

## Appendix E. Causes of Wire Degradation.

The following items are considered principal causes of wiring degradation and should be used to help focus maintenance programs:

- **Vibration** - High vibration areas tend to accelerate degradation over time, resulting in “chattering” contacts and intermittent symptoms. High vibration of tie-wraps or string-ties can cause damage to insulation. In addition, high vibration will exacerbate any existing problem with wire insulation cracking.
- **Moisture** - High moisture areas generally accelerate corrosion of terminals, pins, sockets, and conductors. It should be noted that wiring installed in clean, dry areas with moderate temperatures appears to hold up well.
- **Maintenance** - Scheduled and unscheduled maintenance activities, if done improperly, may contribute to long term problems and wiring degradation. Certain repairs may have limited durability and should be evaluated to ascertain if rework is necessary. Repairs that conform to manufacturers recommended maintenance practices are generally considered permanent and should not require rework. Furthermore care should be taken to prevent undue collateral damage to EWIS while performing maintenance on other systems.

Metal shavings and debris have been discovered on wire bundles after maintenance, repairs, modifications, or STCs have been performed. Care should be taken to protect wire bundles and connectors during modification work. The work areas should be cleaned while the work progresses to ensure that all shavings and debris are removed; the work area should be thoroughly cleaned after the work is complete; and the work area should be inspected after the final cleaning.

Repairs should be performed using the most effective methods available. Since wire splices are more susceptible to degradation, arcing, and overheating, the recommended method of repairing a wire is with an environmental splice.

- **Indirect Damage** - Events such as pneumatic duct ruptures or duct clamp leakage can cause damage that, while not initially evident, can later cause wiring problems. When events such as these occur, surrounding EWIS should be carefully inspected to ensure that there is no damage or potential for damage evident. The indirect damage caused by these types of events may be broken clamps or ties, broken wire insulation, or even broken conductor strands. In some cases the pressure of the duct rupture may cause wire separation from the connector or terminal strip.
- **Contamination** - Wire contamination refers to either of the following situations:

- a. The presence of a foreign material that is likely to cause degradation of wiring.
- b. The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

The contaminant may be in solid or liquid form. Solid contaminants such as metal shavings, swarf, debris, livestock waste, lint and dust can accumulate on wiring and may degrade or penetrate wiring or electrical components.

Chemicals in fluids such as hydraulic fluid, battery electrolytes, fuel, corrosion inhibiting compounds, waste system chemicals, cleaning agents, deicing fluids, paint, soft drinks and coffee can contribute to degradation of wiring.

Hydraulic fluids, deicing fluids and battery electrolyte require special consideration. These fluids, although essential for aircraft operation, can damage connector grommets, wire bundle clamps, wire ties and wire lacing, causing chafing and arcing. Wiring exposed to these fluids should be given special attention during inspection. Contaminated wire insulation that has visible cracking or breaches to the core conductor can eventually arc and cause a fire. Wiring exposed to, or in close proximity to, any of these chemicals may need to be inspected more frequently for damage or degradation.

When cleaning areas or zones of the aircraft that contain both wiring and chemical contaminants, special cleaning procedures and precautions may be needed. Such procedures may include wrapping wire and connectors with a protective covering prior to cleaning. This would be especially true if pressure washing equipment is utilized. In all cases the aircraft manufacturer recommended procedures should be followed.

Waste system spills also require special attention. Service history has shown that these spills can have detrimental effects on aircraft EWIS and have resulted in smoke and fire events. When this type of contamination is found all affected components in the EWIS should be thoroughly cleaned, inspected and repaired or replaced if necessary. The source of the spill or leakage should be located and corrected.

- **Heat** - Exposure to high heat can accelerate degradation of wiring by causing insulation dryness and cracking. Direct contact with a high heat source can quickly damage insulation. Burned, charred or even melted insulation are the most likely indicators of this type of damage. Low levels of heat can also degrade wiring over a longer period of time. This type of degradation is sometimes seen on engines, in galley wiring such as coffee makers and ovens, and behind fluorescent lights, especially the ballasts.